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Actuator

The present invention relates to actuators, and in particular to actuators for use in vehicles.

Electric motors are known to be used as actuators for moving components. Such motors require armature windings and also stator windings. The armature is designed to be a close running fit within the stator in order to maximise the magnetic field effect.

Actuators are also known in the form of linear solenoids. These devices operate by a current being passed through an electromagnetic coil which creates a magnetic field to either attract or repulse a magnetic core of the solenoid.

As is well known, the magnetic effect decreases with distance. As such, most solenoids are designed with as small an air gap as possible. It is also recognised that linear solenoids can only operate over relatively short distances.

An object of the present invention is to provide an improved form of actuator.

Thus, according to the present invention there is provided an actuator including an electromagnetic coil arrangement being movable relative to a magnetic field generator, between first and second positions of the actuator, the actuator being arranged such that, with the actuator in the first position, a pulse of current through the electromagnetic coil arrangement produces a region of magnetic field that repels the magnetic field generator from the first position of the actuator and attracts the magnetic field generator towards the second position of the actuator to move the actuator to its second position.

Preferably the electromagnetic coil arrangement comprises a single electromagnetic coil.

The invention will now be described, by way of example only, with reference to the accompanying drawings on drawing sheets 1/37 to 8/37 in which;

FIGURES 1 and 2 show a first embodiment of an actuator according to the present invention in a first and second position,

FIGURES 3 and 4 show a second embodiment of an actuator according to the present invention in a first and second position,

FIGURE 3A shows an end view of the coil in Figure 3.

FIGURE 4A shows the results of tests carried out on the actuator of Figure 3.

FIGURES 5 and 6 show a third embodiment of an actuator according to the present invention in a first and second position,

FIGURE 7 shows a schematic view of an actuator according to the present invention used to provide for block locking,

FIGURES 8 and 9 show a schematic view of an actuator according to the present invention used to provide for free-wheel locking,

FIGURE 10 shows a schematic view of an actuator according to the present invention used to provide for power unlatching,

FIGURES 11 and 12 show a schematic view of an actuator according to the present invention used to provide for power latching,

FIGURE 13 shows a valve incorporating an actuator according to the present invention, and

FIGURES 14 and 15 show a schematic view of a relay incorporating an actuator according to the present invention.

With reference to Figures 1 and 2, there is shown an actuator 10 having an actuation chassis 12 (only shown in Figure 1 for clarity) upon which is fixedly mounted on electromagnetic coil assembly 14.

The electromagnetic coil assembly 14 includes coil windings 16 connected to power leads 18 and 20. The coil windings form a cylinder within which is positioned a core 22 of magnetic material, such as iron. The core acts to concentrate the magnetic flux lines.

Passing a current through coil winding 16 via power leads 18 and 20 in one direction causes the creation of a south and north pole as indicated in Figure 1. Reversing the direction of current will reverse the position of the north and south pole.

Figure 1 also shows a magnetic field generator in the form of a toggle 24 which includes a mounting portion 26, pivotally mounted via pivot P to the actuator chassis.

A permanent magnet 28 is secured to an end of the mounting portion 26 remote from pivot P.

A permanent magnet 28 includes a north pole N1 and a south pole S1.

Operation of the actuator is as follows;

When no current is flowing through coil windings 16 end 22A of core 22 is magnetically neutral, ie it is neither a north pole or a south pole. As shown in Figure 1, it can be seen that north pole N1 of the permanent magnet 28 is closer to end 22A than south pole S1. As such the predominant magnetic attraction is between end 22A and north pole N1 and hence the toggle 24 remains in a position as shown in Figure 1.

In order to move the toggle from the position shown in Figure 1 to a position shown in Figure 2, current is fed through core windings 16 so as to produce a north pole at end 22A, thus repelling north pole N1 of the permanent magnet and causing the toggle to pivot clockwise around pivot P.

It can be seen that as north pole N1 moves away from end 22A, south pole S1 progressively approaches end 22A and is therefore progressively attracted to the north pole at end 22A, hence further driving toggle 24 in a clockwise direction until it reaches a position as shown in Figure 2.

Once in the position shown in Figure 2, when the electric current flowing through coil winding 16 ceases, end 22A again becomes magnetically neutral, although the toggle remains in the position as shown in Figure 2 by virtue of the greater magnetic attraction between south pole S1 and end 22A.

Toggle 24 can be moved back to the position as shown in Figure 1 by reversing the current so as to provide a south pole at end 22A.

It should be noted that the movement of the toggle is as a result of two sets of forces namely, -

a) repulsion force between two similar magnetic poles, and

b) an attraction force between opposite magnetic poles.

It should also be noted that the repulsive force between two similar poles decreases with distance between those poles. Also, the attractive force between two opposite poles increases as the opposite poles approach each other.

With this in mind, it can be seen that as the pole moves from the position shown in Figure 1 to the position shown in Figure 2, and as the repulsive forces between north pole N1 and the north pole at end 22A progressively decrease, the attractive forces between south pole S1 and the north pole end 22A progressively increase. This provides for a more uniform force across the movement range. This can be contrasted with known devices, such as solenoids, wherein during movement, either similar poles are used to repel each other or opposite poles are used to attract each other. At no time during the use of known solenoids

is an attraction force of opposite poles used in conjunction with repelling forces of similar poles.

Preferably stops 13A and 13B are provided to limit the rotation of the toggle 24 in a clockwise and anticlockwise direction respectively.

With reference to Figures 3 and 4, there is shown a further embodiment of an actuator 110, with components similar to those of actuator 10 labelled 100 greater.

In this case, the electromagnetic coil assembly 114 includes a frame 130 which is connected to end 122B of core 122 and passes outside coil windings 116.

It should be seen that end 130A of frame 130 is positioned at the same end of coil windings 116 but spaced from end 122A. the frame is made of magnetic material, such as iron or steel, an acts to concentrate the magnetic flux lines, ie it acts as a conduit for the magnetic flux lines.

In particular with reference to Figure 3A, it can be seen that end 130A does not completely encircle the coil windings 116, rather it is positioned only on one side of the coil windings in a sector.

When current is fed to coil windings 116 in one direction, a south magnetic pole is generated at end 122A of core 122. Because of the frame 130, the north pole that would normally be expected to be produced at end 122B, is transferred to end 130A of the frame. In particular the core and the frame concentrate the magnetic flux lines. However, there is an "air gap" between ends 130A and 122A which the magnetic flux has to jump. The magnetic flux lines in this air gap are shown as lines 132.

It can be seen, especially from Figure 3A, that the magnetic flux lines 132 are concentrated in a sector of the coil, as they pass from end 130A to end 122A.

Consideration of the toggle 124 shows, that in this case, the permanent north pole, N2 and permanent south pole S2 are situated at opposite ends of the toggle on either side of pivot P2, with north pole N2 being situated proximate the electromagnetic coil.

Operation of the actuator 110 is as follows:

Current is fed through coil windings 116 so as to produce a north pole at end 130A and a south pole at end 122A. This causes permanent north pole N2 to be repelled from the north pole at end 130A, and simultaneously attracted towards the south pole at end 122A, thus causing the toggle to pivot clockwise to the position shown in Figure 4.

The toggle can be moved back to the position shown in Figure 3 by reversing the current through the coil such that a north pole is provided at end 122A and a south pole is provided at end 130A.

Experiments were carried out on a sample actuator 110 in order to optimise the position of the toggle 124 relative to the electromagnetic coil assembly 114. Thus, the position of pivot P1 was adjusted so as to vary the gap G. A voltage was applied across power leads 118 and 120 and was increased until the toggle moved from one position to the other position. The results are shown in Figure 4A and surprisingly, with a small gap G of 0.5 mm, approximately 7 volts was required to move the toggle. However, as the air gap progressively increased, a lower voltage was required to actuate the device, thus with an air gap of 1.0 mm approximately 4.5 volts was required and with an air gap of 1.5 mm, approximately 3.5 volts was required.

This was a surprising result since it is generally accepted that magnetic devices operate best (and hence require lower power) with small air gaps.

This is best understood by considering the fact that magnetic flux cannot easily turn through sharp corners. Thus consideration of Figure 3 shows that the magnetic flux lines 32 pass in an arc between ends 130A and end 122A. Where flux lines 132 cross those flux lines emitted by the permanent magnet, movement of the toggle will more easily occur.

However, where the gap is too small, movement of the toggle is harder to achieve since the electromagnetic flux 132 passes through the permanent magnet rather than across its magnetic field.

In a further embodiment, the single electromagnetic coil assembly 114 could be replaced by a pair of electromagnetic coils positioned adjacent one another and wired in series such that north pole N2 can be simultaneously repelled from a north pole of 1 magnetic coil and attracted to a south pawl of the adjacent magnetic coil.

Consideration of Figure 5 shows a further embodiment of an actuator 210 which includes an electromagnetic coil assembly 214 fitted to a chassis (not shown) of the actuator. Yoke 240 is made of a non-magnetic material, such as a plastics material. Mounted in end 240A of yoke 240 is a first permanent magnet 242, and mounted in end 240B of yoke 240 is a second permanent magnet 244.

It can be seen that south pole S3 of permanent magnet 242 faces south pole S4 of permanent magnet 244. Between the south poles S3 and S4 is situated the coil assembly 214. The yoke 240 together with the permanent magnets 242 and 244 is moveable via sliders (not shown) between the positions shown in Figure 5 and Figure 6. Starting at the position shown in Figure 5, by passing current through coil assembly 214 in a first direction, a north pole is created at end 222A of the core and a south pole is created at end 222B causing the yoke to move to the position as shown in Figure 6.

Reversing the current through the coil will reverse the magnetic poles, causing the yoke to move back to the position as shown in Figure 5.

It can be seen that ends 22A and 22B act as stops to limit the downward and upward movement of yolk 240.

Actuators according to the present invention can be used in many fields, though in particular on vehicles such as cars, and in particular to provide for security functions. It is therefore advantageous that they are capable of functioning on cars which have a “12 volt”

system. Thus advantageously the actuators can be used with an operating voltage of 14 volts (alternator output voltage), 12 volts (battery voltage) or 8 volts (partially drained battery). Similarly, where the actuators are used on vehicles with a "24 volt" system it is advantageous for them to operate at 28 volts, 24 volts and 16 volts respectively and where the actuators are used on vehicles with a '42 volt" system it is advantageous for them to operate at 49 volts, 42 volts and 28 volts respectively.

In all embodiments described thus far, the electromagnetic coil assembly has been fixed relative to the chassis of the actuator and the magnetic field generator (permanent magnet) has been caused to move. Advantageously, this allows for the power leads to the electromagnetic coil assembly to remain stationary. However, in further embodiments, and under certain installations it may be preferable for the permanent magnets to remain stationary and to allow the electromagnetic coil assembly to move.

Furthermore, the magnetic field generator has thus far only been shown to include a permanent magnet. In further embodiments, the permanent magnet could be replaced by a further electromagnetic coil.

In further embodiments, the electromagnetic coil 214 could be replaced by a permanent magnet with the permanent magnets 242 and 244 being replaced by electromagnetic coils wired in series such that one of the electromagnetic coils is attracted towards the adjacent magnet whilst the other of the electromagnetic coils is repelled from the adjacent magnet.

With reference to Figure 7 there is shown a schematic view of a latch arrangement 50 wherein a door handle 51 is connected to a door latch 52 via a rod 53. Actuation of door handle 51 by pivoting it about pivot P4 causes the rod to move to the left and unlatch the latch 52, allowing an associated door (not shown) to be opened.

The rod 53 carries an abutment 54 situated proximate a further abutment 55 mounted on the door. An actuator 56 according to the present invention carries an actuator abutment 57 which, by operation of the actuator can be inserted into the space between abutments 55 and 54, thus preventing unlatching of the latch by blocking movement of the rod 53 and

hence locking the door. The actuator 56 can be operated to withdraw the abutment 57 to the position shown in dotted outline, thus allowing abutment 54 to move to the left upon operation of the door handle, thus unlocking the door. In a further preferred embodiment the actuator and associated components required for locking can be situated within a latch housing of the latch 52.

Figures 8 and 9 show a schematic view of a "free wheel" type of locking system situated within latch housing 66. Here operation of door handle 60 causes lever 61 to pivot anti-clockwise about pivot P5 causing slider 62 to move to the right and push pawl lifter 63 to the right, thus releasing the latch.

Slider 62 is slidingly mounted on toggle 64 of actuator 65 according to the present invention. Toggle 64 pivots about pivot P6. Actuation of actuator 65 causes toggle 64 to move to the position as shown in Figure 9, such that actuation of the inside door handle 60 moves lever 61 such that it bypasses slider 62 and does not cause release of the latch. It can be seen that Figure 8 shows the system in an unlocked condition and Figure 9 shows the system in a locked condition.

Where handle 51 or 60 is an inside handle then the system provides for a child safety and/or for superlocking (or deadlocking) in conjunction with a lockable outside handle.

Figure 10 shows a door latch 70 including a rotating latch bolt in the form of claw 71. A striker 72 can be retained in the position as shown in Figure 10 by virtue of toggle 73 acting as a claw pawl against claw abutment 74. Actuation of actuator 75 according to the present invention causes the toggle 73 to rotate anti-clockwise about pivot P7, thus releasing the claw which can then rotate anti-clockwise to allow the striker to be withdrawn from the claw mouth 76. Stops can be provided to limit the clockwise and anticlockwise rotation of toggle 73. In particular edge 71A of claw 71 can be used to limit clockwise rotation of toggle 73.

Figures 11 and 12 show a latch arrangement as described in the applicant's earlier granted patent GB2328242. For a full explanation of the operation of the latch 80, the reader is

referred to the earlier patent. However, in summary, latch 80 is a power latching latch, ie one in which when the door has been closed to the position as shown in Figure 11, an actuator 81 is caused to move lever 82 in an anti-clockwise direction such that pawl 83 engages in notch 84 of claw 85 driving claw 85 to the position as shown in Figure 12. In this case, actuator 81 is an actuator according to the present invention.

An actuator of the present invention may also be used to open a fuel filler flap by having the flap (not shown) mounted to the toggle 24, 124. Alternatively the actuator may be used to unlatch a flap that is resiliently biased towards an open position, for example.

Figure 13 shows a valve 90 having an inlet 91 and alternate outlets 92 and 93. Toggle 94 sits within the valve body 95 and selectively blocks outlet 92 or outlet 93. As shown in Figure 13, liquid or gas that is pumped through inlet 91 will exit via outlet 93. Actuation of the actuator 96 will cause the toggle 94 to rotate anticlockwise, blocking outlet 93 and opening outlet 92. It can be seen that portions of the valve body act as stops to limit the clockwise and anticlockwise rotation of toggle 94.

Figures 14 and 15 show a relay 97 having an actuator 97A according to the present invention attached to a relay contact 98. A further relay contact 98A is mounted on the body of the relay and the relay contact can be opened or closed by actuation of the actuator 97A.

There now follows a description of an embodiment of an actuator according to the present invention used as part of a latch arrangement.

The present invention can be used in latch arrangements, and in particular latch arrangements for use within doors of cars (automobiles).

Known car doors include latches for releasably retaining the car door in a closed position. Such latches can be locked when the car is left unattended or even when an occupant is in the vehicle so as to prevent access to the vehicle by unauthorised people.

Such latches can be moved between a locked and unlocked condition either by manual means such as by operating an inside sill button or an exterior key barrel, or they can be powered between the locked and unlocked conditions by a power actuator, which can be controlled remotely by, for example, infra red devices.

A problem with such power locking/unlocking is that in the event that power is lost e.g. during a road traffic accident or as a result of a flat battery, it may not be possible to change the state of the lock. Thus where a vehicle is in use and the doors are locked and the vehicle is involved in a road traffic accident, the occupant of the vehicle may find themselves locked in the vehicle immediately following the crash and this clearly has safety implications.

Furthermore the power actuator is expensive to produce and manufacture.

Thus in one form of the invention there is provided a latch arrangement including a latch, a release mechanism, a manually actuable element and a control means including an actuator according to the present invention, the latch being operable to releasably retain a striker in use, the release mechanism being capable of being moved by the manually actuable element from a rest position through an unlocked position to a release position wherein it unlatches the latch, the control means having a locked condition at which actuation of the manually actuable element does not cause unlatching of the latch and an unlocked condition at which during an initial movement of the manually actuable element, the release mechanism achieves the unlocked position and during subsequent movement of the manually actuable element, the release mechanism achieves the unlatch position.

Advantageously movement of a door handle therefore provides two functions, namely that of unlocking of the latch mechanism and also release of the latch mechanism. Furthermore

the control means can be configured to ensure the latch arrangement remains in a locked condition, independent of actuation of any door handles (inside or outside doors) when necessary.

Preferably the release mechanism includes a release link having an abutment operable to move a latch release element.

Preferably when the control means is in the locked position actuation of the manually actuable element moves the abutment, but the abutment does not move the latch release element.

Preferably the abutment is mis-aligned with the release element in the rest condition.

Preferably the release link is operably movable by a release lever.

Preferably a part of the release mechanism is retained in a rest position by the control means to provide for the lock condition.

Preferably said part of the release mechanism is retained by magnetic attraction.

Preferably said part of the release mechanism is retained a control pawl.

Preferably said part of the release mechanism is a lock/unlock lever which is retained in a first position when the control means is in its locked condition and is allowed to moved to a second position when the control means is in its unlocked condition.

Preferably the lock/unlock lever is connected to the release link by a connector.

Preferably the lock/unlock lever, connector and release link substantially move in unison during said initial movement of the manually actuable element.

Preferably the lock/unlock, connector and release link rotate about a pivot during said initial movement.

Preferably the pivot mounts the lock/unlock lever on a chassis of the latch arrangement.

Preferably the lock/unlock lever remains stationary during said subsequent movement of the manually actuable element.

Preferably the release mechanism is designed to return to the rest position from the release position upon release of the manually actuable element.

Preferably the release mechanism is biased to the rest position by resilient means.

Preferably a first resilient means biases the release mechanism to the unlocked position from the released position and a second resilient means biases the release mechanism to the rest position from the unlock position.

Preferably the latch is further movable between a latched and released position by a powered released actuator.

Preferably the control means is movable between the locked and unlocked conditions by manual operation of a coded security device such as a key.

This form of the invention will now be described, by way of example only, with reference to the accompanying drawings on drawing sheets 9/37 to 12/37, in which:-

FIGURE 1 is a view of a latch arrangement according to this form of the present invention;

FIGURE 1A is an enlarged view of part of the figure 1

FIGURE 1B is a view similar to figure 1A with the magnetic pawl in a different position;

FIGURE 2 shows the latch arrangement of figure 1 part way through an opening operation in an unlocked but latched condition;

FIGURE 3 shows the latch arrangement of figure 1 at the end of an opening operation in an unlatched condition; and

FIGURE 4 shows the latch arrangement of figure 1 wherein an attempt has been made to open the latch whilst in a locked condition.

With reference to the figures there is shown a latch arrangement 10 having a latch 12 (only part of which is shown), a release mechanism 16, powered control means (actuator) 18 and manually actuable elements in the form of inside handle 20 and outside handle 21.

The latch 12 is mounted on a car door and is operable to releasably retain a striker mounted on fixed structure of the car, such as a B post or a C post. The latch 12 typically might include a latch bolt in the form of a rotating claw which engages the striker. To ensure the claw retains the striker, a pawl can be provided to retain the latch bolt in its closed position. The pawl includes a latch release element in the form of a pawl pin 14.

With the pawl pin 14 in position A as shown in figure 1, closing of the door will cause the rotating claw to engage the striker and the pawl will then retain the striker in the closed position. Movement of the pawl pin 14 to the position B as shown in figure 1 will release the pawl from engagement with the claw thus allowing the striker to be released from the claw and allowing the door to open. Thus with the pawl pin in the position A of figure 1 the latch can be latched to the striker and with the pawl pin in the position B of figure 1 the latch can be unlatched from the striker.

The release mechanism includes release lever 26, release link 28, connector link 30 and lock/unlock lever 32.

Release lever 26 is pivotally mounted about pivot C on chassis 24 of the latch arrangement. One end 26A of release lever 26 is connected via linkage 34 (shown schematically) to a manually actuable element in the form of an inside handle 20.

End 26A is further connected by a further linkage 35 (shown schematically) to a further manually actuable element in the form of an outside door handle 21.

Operation of either handle 20 or 21 causes the release lever to rotate clockwise about pivot C.

End 26B of release lever 26 is connected via pivot D to end 28A of release link 28.

End 28B of release link 28 includes an abutment 22 for engagement with pawl pin 14 as will be further described below.

Release link 28 is connected to end 30A of connector 30 by pivot E which is positioned between end 28A and 28B. End 30B of connector 30 is connected to end of arm 32A of lock/unlock lever 32 by a pivot F.

Lock/unlock lever 32 further includes arm 32B having pin 37 and arm 32C having abutment 38 and 39. Lock/unlock lever 32 is pivotally mounted about pivot G onto chassis 24.

Lock/unlock lever 32 is made from mild steel and hence in particular abutment 38 is made from a ferromagnetic material though in further embodiments this need not be the case (see below).

An actuator according to the present invention is provided in the form of a powered control means 18 which includes electromagnet 42 and magnetic pawl (toggle) 44.

Electromagnet 42 is mounted on chassis 24 and includes windings 46, core 48 and electric leads 50 and 51. Pawl stop 52 is provided on one side of the electromagnet 42 and is made of magnetic material (such as iron or steel) and thus acts as part of a frame, one end of which is connected to the core 48.

Magnetic pawl 44 includes a permanent magnet and is pivotally mounted about pivot H onto chassis 24. End 44A of pawl 44 includes abutment 54, 56 and 58, which will be further described below.

A tension spring 60 is connected to chassis 24 and release lever 26 and acts to bias release lever 26 in an anticlockwise direction when viewing figure 1.

A further tension spring 62 (only shown in figure 3 for clarity) biases pin 37 and pivot 38 together.

In further embodiments different forms of springs can be used in particular springs acting in torsion (clock springs) in place of tension springs 60 and 62 to perform the same biasing action.

A lock/unlock lever stop 64 is mounted on the chassis 24.

As a result of tension spring 62 end 28A of release link 28 is biased into engagement with pin 37. In further embodiments the end of release lever 26 could engage pin 37 as could a part of pivot D.

Magnetic pawl 44 has a south pole at end 44B and a north pole at end 44A.

Applying DC current to the windings 46 via electric leads 50 and 51 in a first direction will create a magnetic field around the electromagnet which will bias the north pole in end 44A of magnetic pawl 44 to the left when viewing figure 1 i.e. anticlockwise about pivot H until abutment 54 engages pawl stop 52.

Applying DC current in a second direction to windings 46 via electric 50 and 51 will cause a different magnetic field to form around the electromagnet such that north pole end 44A of magnetic pawl 44 is biased to the right when viewing figure 1 i.e. clockwise around pivot H until such time as abutment 56 engages end 33 of arm 32C of lock/unlock lever 32 (see figure 1B). Under these conditions abutment 58 is opposite abutment 39 and will prevent rotation of lock/unlock lever 32 anticlockwise about pivot G (see below).

Note that to move the magnetic pawl between the positions as shown in figures 1A and 1B it is only necessary to apply a short pulse (e.g. 50 ms) of current to windings 46 in the appropriate direction since under normal circumstances once the magnetic pawl 44 has achieved one of the positions as shown in figures 1A or 1B there are no forces which tend to move it out of that positions.

Note that in a preferred embodiment the centre of gravity of pawl 44 is substantially at pivot H since, in the event of a road traffic accident, such an arrangement will not tend to rotate the pawl as a result of acceleration or deceleration occurring during the accident.

Note that in a further preferred embodiment a relatively light detent is provided to maintain the magnetic pawl 44 in either of the positions as shown in figure 1A and figure 1B which can nevertheless be overcome by manual operation of the key or by pulsing the electromagnet.

It is also possible to prevent rotation of lock/unlock lever 32 anticlockwise about pivot G by applying and maintaining DC current in the first direction to windings 46 since abutment 38 is made from a ferromagnetic material and will therefore be magnetically attracted to electromagnet 42.

The powered control means 18 has three conditions namely a first condition at which no power is applied to the windings and the magnetic pawl 44 is in the position as shown in figure 1B.

A second condition at which power is supplied and maintained in a first direction to windings 46 thus attracting abutment 38 and ensuring that the magnetic pawl is positioned as shown in figure 1 and 1A.

A third condition at which no power is supplied to the windings 46 and the magnetic pawl 44 is in position as shown in figure 1, wherein the permanent North magnetic pole is attracted to the magnetic material of pawl stop 52.

Operation of the latch arrangement is as follows.

With the control means 18 in the third condition the door can be manually opened as follows.

As mentioned previously with the control means in the third condition the magnetic pawl is positioned as shown in figure 1 and thus does not restrict rotation of the lock/unlock lever 32 in an anticlockwise direction.

Furthermore no power is supplied to the windings 46 and thus the electromagnet also does not restrict movement of the lock/unlock lever 32 in an anticlockwise direction.

Initial movement of either the inside handle 20 or outside handle 21 moves the release lever 26 in a clockwise direction about pivot C to the unlocked position as shown in figure 2.

It should be noted that lock/unlock lever has rotated anticlockwise about pivot G to a position where arm 32A has come into abutment with abutment 64. It should also be noted that abutment 38 has become disengaged from the electromagnet 42.

It can also be seen from figure 2 that end 28A of release link 28 has remained in contact with pin 37. Thus connector 30 and release link 28 have also substantially rotated about pivot G. Note that as shown in figure 2 abutment 22 had become aligned with pawl pin 14. This can be contrasted with the position of abutment 22 as shown in figure 1 where it is not aligned with pawl pin 14.

Further movement of the inside or outside door handle moves the release lever 26 from the position as shown in figure 2 to the position as shown in figure 3.

In view of the fact that arm 32A of lock/unlock lever 32 is in abutting engagement with abutment 64, lock/unlock lever 32 cannot rotate further in an anticlockwise direction. Thus connector 30 is caused to rotate anticlockwise about pivot F relative to lock/unlock lever 32. This results in abutment 22 of release link 28 moving into engagement with pawl pin 14 and moving it from position A as shown in figure 2 to position B as shown in figure 3.

As previously mentioned movement of the pawl pin from position A to position B causes the latch to unlock.

When the inside and outside handles are released, spring 60 and spring 62 return the release mechanism 16 and pawl pin 14 to the position as shown in figure 1.

Note that whilst the movement of the inside or outside handle and hence movement of the release lever 26 has been described in two stages, such two stage movement is not discernible by a person operating the door handles. Furthermore the mechanism is designed to move seamlessly from the position as shown in figure 3 to the position as shown in figure 1.

With the control means in its second condition i.e. DC current supplied to the windings in the first direction and the magnetic pawl is in a position as shown in figure 1 the lock/unlock lever 32 is maintained in the position as shown in figure 1 by magnetic attraction.

Thus operation of an inside or outside door handle will cause the release lever 26 to rotate in a clockwise direction as shown in figure 1 which will result in end 28A of release link 28 immediately disengaging pin 37 such that the release lever 26, release link 28 and connector 30 moves to the position as shown in figure 4.

It should be noted that whilst abutment 22 has being caused to move, in view of the fact that it was initially mis-aligned with pawl pin 14, such movement has resulted in abutment 22 bypassing pawl pin 14 and not imparting any movement to pawl pin 14. Thus whilst the inside or outside handle has been moved, the door has not become unlatched. Note that in further embodiments it is possible to arrange an abutment such as abutment 22 to be permanently aligned with a latch release element such as pawl pin 42 but remote therefrom such that with the latch arrangement in a locked condition the abutment approaches the pawl pin but does not move it and with the latch arrangement in an unlocked condition the abutment approaches, engages and then moves the pawl pin.

It can be seen that with the control means in its second condition, the door latch remains in a locked condition.

With the control means in the first condition i.e. where there is no power to the windings 46 but the magnetic pawl 44 is in a position as shown in figure 1B, anticlockwise rotation of the lock/unlock lever is again prevented though this time by co-operation of abutments 39 and 58. Thus actuation of the inside or outside handles will again cause release lever 26, release link 28 and connector 30 to move to the position as shown in figure 4.

Consideration of figure 2 shows schematically a power actuator P which is independently operable to release the latch.

Further shown schematically is a coded security device 70 in the form of an externally mounted key barrel into which can be inserted a key. Actuation of the key barrel via the key is capable of moving the magnetic pawl between the positions shown in figures 1A and 1B.

The latch arrangement is configured such that when the associated vehicle is in use the control means is set to its second condition i.e. power is maintained to the windings. Under such circumstances electric power lost to resistance in the windings 46 can be compensated for by the fact that the engine of the vehicle is running and hence the battery recharging system (such as an alternator) can recharge the battery to ensure it does not go flat.

When the vehicle is parked and left unattended the control means can be set to its first condition to lock the latch. Note that the control system does not cause any drain to the vehicle battery in its first condition.

The control mechanism can also be set to its third condition when the vehicle is parked and is required to be in an unlocked condition. Note that in the third condition there is no drain on the battery.

The control means can be changed between its first and third condition by applying a pulse of electrical power to the windings in an appropriate direction.

With the vehicle in use and the control means in its second condition, as mentioned above, the lock/unlock lever 32 is maintained in the position as shown in figure 1 by power been fed to the electromagnet. In the event of a power failure, such as might occur following a

road traffic accident, the control means will by definition change to its third condition and hence the doors will become unlocked and occupants of the vehicle will be able to escape from the vehicle.

With the vehicle parked and with the control means in its first condition i.e. with the vehicle locked, in the event that the vehicle battery is flattened, perhaps as a result of a interior light being left on, pulsing of the electromagnet to move the control means from the first and third condition to unlock the vehicle will not be possible. However, it is nevertheless possible to manually unlock the vehicle by use of the key and key barrel 70. The key and key barrel can also be used to lock the vehicle if necessary.

It should be noted that only when the vehicle is in use is power continually fed to windings 46. When the vehicle is parked power is only momentarily fed to windings 46 to change between the locked and unlocked condition.

Such an arrangement therefore significantly reduces the likelihood of flattening the battery when the vehicle is parked but the nevertheless allows opening of the doors in the event of power loss following a road traffic accident.

It should be noted that the electromagnet 42 need only be strong enough to retain the lock/unlocked lever 32 in the position shown in figure 1 when the electromagnet is in its second condition i.e. when power is being supplied to the electromagnet. Thus the electromagnet has to be strong enough to overcome the forces in tension spring 60 during initial movement of inside or outside handle and it has to overcome the forces in tension spring 60 and 62 during a subsequent movement of the inside or outside handle. Note that the electromagnet is not required to be strong enough to move the lock/unlock lever from the position as shown in figure 2 to a position such that abutment 38 engages with the electromagnet.

As mentioned above the control means 18 has two ways of preventing rotation of the lock/unlock lever 32, namely by permanently energisation of the windings 46 or by movement of magnetic pawl 44 to the position as shown in figure 1B. In further embodiments, in particular when no power release P is provided, the control means can be used to simply lock and unlock the vehicle e.g. when parked. As such it is only necessary for the windings 46 to be pulsed to move the magnetic between the positions as shown in figures 1A and figure 1B. As such the electromagnet 42 is not required to attract lock/unlock lever 32 which can therefore be made of a non ferromagnetic material, such as a plastics material. Under these circumstances it is necessary to have a manual override

system operable by the inside handle (but not the outside handle) such that when the inside handle is moved the magnetic pawl 44, if in the position as shown in figure 1B, is moved to the position as shown in figure 1A. Once the magnetic pawl is in the position as shown in figure 1A, the latch release mechanism 16 can then operate in its two stage manner i.e. alignment of abutment 22 with pawl 14 followed by movement of pawl 14 from position A to position B as shown in figure 1 to open the latch. Under such an arrangement it is preferable that the release mechanism 16 fully returns to the rest position upon release of the inside handle i.e. abutment 22 becomes mis-aligned with pawl pin 14.

There now follows a description of an embodiment of an actuator according to the present invention used as part of a latch arrangement, and in particular latch arrangements for use within doors of cars.

In this form of the invention there is provided a latch arrangement including a latch, a manually actuable element, a release mechanism and a power control means including an actuator according to the present invention, the latch being operable to releasably retain a striker in use, the release mechanism being capable of being moved by the manually actuable element from a latched position to an unlatched position wherein it unlatches the latch, the power control means having a first, second and third condition in which:-

with the power control means in the first condition the control means is in a non powered condition and actuation of the manually actuable element does not cause the release mechanism to unlatch the latch,

with the power control means in the second condition the powered control means is in a powered condition and actuation of the manually actuable element does not cause the release mechanism to unlatch the latch,

and with the power control means in the third condition the power control means is in a non powered condition and actuation of the manually actuable element causes the release mechanism to unlatch the latch.

Preferably a part of the release mechanism is retained in a locked position by the control means to provide for a lock condition of the latch.

Preferably said part of the release mechanism is retained by magnetic attraction.

Preferably said part of the release mechanism is retained by a pawl.

Preferably said part of the release mechanism is a lock/unlock lever which is retained in the first position by the control means to provide for the lock condition and is allowed to move to a second position to provide for the unlocked condition.

Preferably the control means includes a electromagnet to retain said part of the release mechanism in the unlocked position.

Preferably the electromagnet is incapable of moving the said part of the release mechanism from the unlocked to the locked position.

Preferably the control means includes a magnetic pawl movable between a locked and unlocked position.

Preferably the electromagnet is pulsed to move the pawl between the locked and unlocked position.

Preferably the pawl is pivotally movable and the centre of gravity of the pawl is substantially at the axis of the pivot.

Preferably the release mechanism is designed to return to the rest position from the release position upon release of the manually actuable element.

Preferably the release mechanism is biased to the rest position by resilient means.

Preferably a first resilient means biases the release mechanism to the unlocked position from the released position and a second resilient means biases the release mechanism to the rest position from the unlock position.

Preferably unlatching of the latch arrangement causes the release mechanism to move to a locked condition

Preferably the release mechanism can be retained in the locked condition whilst the latch is in its unlatched condition.

Preferably the release mechanism is retained in the locked condition by putting the control means into the first condition

Preferably the release mechanism is retained in the locked condition by putting the control means into the second condition.

Preferably the latch is further movable between a latched and released position by a powered released actuator.

Preferably the control means is movable between the locked and unlocked conditions by manual operation of a coded security device such as a key.

This form of invention will now be described, by way of example only, with reference to the accompanying drawings and drawing sheets 13/37 to 17/37 in which:-

FIGURES 7 to 7D shows an embodiment of a latch arrangement according to this form of the present invention.

With reference to figures 7 to 7D there is shown a further embodiment of a latch arrangement 310 having components which fulfil substantially the same function a those in latch arrangement 10 labelled 300 greater. Again, an actuator according to the present invention is provided in the form of a powered control means 318. Pawl stop 52 is provided on one side of the electromagnet 42 and is made of a magnetic material (such as iron or steel) and thus acts as part of a frame, one end of which is connected to the core 48.

Further shown is a latch bolt in the form of a rotating claw 1 pivotably mounted about pivot W which is retained in the position as shown in figure 7 by pawl 2 which is pivotably mounted about pivot X. A striker 3 can be retained in the position as shown in figure 7 to latch a door in a closed position. In this case claw 1 includes a cam lug 4 on the outer periphery thereof which engages with lug 5 of lock/unlock lever 332 as will be further described below.

In this case there is further included an abutment 390 which limits anticlockwise rotation of release lever 26.

Figure 7A shows the latch arrangement 310 in an unlocked condition wherein release lever 326 is in abutment with abutment 390, lock/unlock lever 332 is in abutment with abutment 64 and end 328A of release link 328 is in abutment with pin 337 with abutment 338 being remote from electromagnet 342. In this position abutment 332 aligns with pin 314. Note that the position of components shown in figure 7A is equivalent to the position of similar components as shown in figure 2.

Figure 7B shows the latch arrangement 310 in a locked condition wherein electrical power is fed to windings 346 to maintain abutment 338 in engagement with the electromagnet. Note that release lever 326 is still in engagement with abutment 390 whilst lock/unlock

lever 332 is no longer in engagement with abutment 64 and end 328A of release link 328 is no longer in engagement with pin 337. Note also that abutment 332 is now mis-aligned with pawl pin 314. Thus pivotal movement of the release lever 326 in a clockwise direction will cause abutment 322 to bypass pin 314 and thus the door will remain closed.

Consideration of figure 7A shows that in the event that the release lever 326 is pivoted in a clockwise direction so as to disengage abutment 390, the release lever 326, release link 328, and connector 330 will move to the position as shown in figure 7C resulting in abutment 322 engaging and moving pin 314 to position B as shown in figure 7C, thus allowing the door the to open.

It should be noted that the latch arrangement 310 only momentarily achieves the position as shown in figure 7C since once in this position the claw 1 rotates anticlockwise about pivot W which simultaneously releases the striker 3 from the mouth of the claw and also causes cam lug 4 to contact lug 5 thus driving the lock/unlock lever to the position as shown in figure 7D. This in turn allows the pawl pin 314 to return to position A and causes the connector 330 and release link 328 to adopt the position as shown in figure

Note that as shown in figure 7D, the release lever is disengaged from abutment 390 i.e. an inside or outside door handle is still in an actuated position.

With the inside or outside handle in its actuated position, the door latch can then be locked either by supplying an maintaining power to windings 346 or by pulsing windings 346 such that pawl 344 moves clockwise to a position equivalent to that shown in figure 1B or by manual operation of the key again moving pawl 344. Subsequent release of the inside or outside door handle will either return the latch arrangement to the position as shown in figure 7B (when power is supplied and maintained to windings 346) or to the position as shown in figure 7B except with the pawl moved across.

Alternatively where no power is supplied to windings 346 then neither the electromagnet or pawl 344 will restrict rotational movement of the lock/unlock lever 332 which, upon release of the inside or outside door handle will return to the position as shown in figure 7C.

It can be seen that electromagnet 342 is therefore only required to hold the lock/unlocked lever in the locked position as shown in figure 7 and is not required to return it to that position from the unlocked position since this is carried out by co-operation between cam lug 4 and lug 5.

In an alternative embodiment it is possible to provide an electromagnet which is sufficiently powerful to move the lock/unlock lever from the position as shown in figure 7A to the position as shown in figure 7B so as to be able to lock the door without having to open the door.

There now follows a description of an embodiment of an actuator according to the present invention used as part of a latch arrangement.

The present invention can be used in a latch arrangement, and in particular a latch arrangement for land vehicles such as cars.

Known vehicle door latches are required to keep the associated vehicle door in a closed position in the event of a road accident. Under such circumstances, the closed vehicle door contributes significantly to the strength of the passenger safety cell. Conversely, in the event that the door is forced open during a road accident, the passenger safety cell strength is severely compromised, thus endangering the passengers and driver of the vehicle.

It is known for an impact occurring during a crash to deform the vehicle door such that the normal release mechanism of the latch is inadvertently operated, thus releasing the door.

An object of the present invention is to provide a door latch which is less likely to unlatch during a crash.

Thus in one form of the invention there is provided a latch arrangement including a latch and a release mechanism operable such that with the latch in an unlocked latched first condition, an initial operation of the release mechanism changes the state of the latch to a latched second condition, different from the first condition, wherein a subsequent operation of the release mechanism unlatches the latch in which an actuator according to the present invention can be used to lock the latch.

It is also known to have latches which are power openable, that it so say the mechanism by which the latch is opened can be driven by an actuator such as an electric motor.

The signal to operate the power actuator is generated by an initial movement of an outside door handle associated with the latch/power actuator. Since the initial movement of the outside door handle simply operates a signalling switch, the force required to lift the outside door handle during this initial movement is very low.

However, in the event of mail function of the power actuator, further movement of the outside door handle causes mechanical components of the door latch to be moved to release the latch. Thus, it would be appreciated that the force required to lift the door

handle during this subsequent movement is considerably more that that force required to lift the handle during the initial movement.

There is an ongoing requirement for vehicles to have reduced noise levels, and in particular reduce wind noise levels. Reduced wind noise levels can be achieved by increasing the seal load acting between the door and the adjacent door aperture of the vehicle. However, an increase in seal load also requires an increase the force required to unlatch the latch.

It is difficult to control the tolerances on seal loads between various door of a vehicle, and as such the force required to unlatch the latch on different doors of the same vehicle varies significantly. As such, during power opening of a door latch, different doors of the same vehicle may take different times to open.

In particular, where a power actuator takes a significantly longer time than usual to open its associated door, the person lifting the door handle may well have moved the door handle from the initial position into the manually opening phase of the door handle.

As such, a person opening different doors of the same vehicle can be required to input significantly different forces into each door handle.

An object of a preferred embodiment of the present invention is to alleviate this problem.

Thus, according to the present invention the latch arrangement is preferably further operable by a power actuator.

It can be seen that providing a power openable door latch which requires an initial and subsequent operation of a release mechanism, the initial operation can be chosen to move only a certain number of components of the latch. In particular the tolerances on these particular components can be tightly controlled and furthermore the force required to move these components can be relatively low. Thus, the force required to fully actuate an outside door handle on the first occasion can remain low. Furthermore, this force is consistent when compared with other door handles of the same vehicle.

The time taken to manually fully lift an outside door handle is considerably longer than the time required for the power actuator to unlatch the latch. Thus under normal circumstances, when the latch is being power unlatched, the door will open at sometime whilst the outside door handle is being lifted, even though the action of lifting the outside

door handle is not acting to unlatch the latch and it is therefore more easy to achieve a consistent "feel" to all latches on a particular vehicle.

Preferably the latch has a locked condition such that, when in the locked condition, any number of operations of the release mechanism does not unlatch the latch.

Preferably the latch arrangement includes a latch bolt releasably retainable in a closed position by a first pawl.

Preferably the first pawl is operable by a pawl lifter, the pawl lifter being moveable relative to the pawl from a first relative position corresponding at least to the unlocked latched first condition to a second relative position corresponding at least to the latched second condition.

Preferably the pawl lifter is moveable relative to the first pawl by virtue of a lost motion connection between the pawl lifter and first pawl.

Preferably the lost motion connection is in the form of a projection on one of the pawl lifter and first pawl engaging a slot in the other of the pawl lifter and first pawl.

Preferably one of the pawl lifter and first pawl is pivotally mounted, preferably both being pivotally mounted, preferably both being pivotally mounted about the same axis.

Preferably the pawl lift is biased to the first relative position.

Preferably the pawl lifter is retainable in the second relative position by a second pawl.

Preferably with the first pawl in its released position, the second pawl is not capable of retaining the pawl lifter in its second relative position.

Preferably with the latch bolt in its open position, the latch bolt engages the first pawl to keep the first pawl substantially in its released position.

Preferably the first pawl includes an abutment engageable with the second pawl such that with the first pawl in its released position, the abutment engages the second pawl to move the second pawl to its released position.

Preferably the release mechanism includes a ratchet mechanism having a first and second ratchet tooth to provide for the changing of the state of the latch between the unlocked latched first condition and the latched second condition and between the latched second condition and the unlatched condition upon respective engagement with a ratchet abutment.

Preferably the ratchet teeth and ratchet abutment are in substantially permanent operable engagement.

Preferably the ratchet teeth and ratchet abutment are capable of being maintained in a disengaged position to provide for locking of the latch.

Preferably one of the first and second ratchet teeth and ratchet abutment are mounted on a ratchet lever.

Preferably the ratchet abutment is mounted on a ratchet lever and the ratchet teeth are mounted on the pawl lifter.

Preferably the ratchet lever is pivotally mounted on a release lever.

Preferably the release lever is pivotally mounted on a chassis of the latch.

Preferably the ratchet lever is pivotally connected at a first link pivot to a link, said link constraining the first link pivot to move about an arc when the latch is locked.

Preferably the link is pivotally mounted on a lock link at a second link pivot.

Preferably the lock link can be retained in a lockable position to lock the latch.

Preferably with the latch in an unlocked condition, the lock link can be moved to its lockable position by return movement of the release mechanism.

Preferably the lock link is moved to its lockable position by return movement of the release lever.

Preferably said latch arrangement is further operable by a power actuator.

Preferably the power actuator is connected on a first pawl transmission path side of the ratchet mechanism.

Preferably the power actuator is connected on a first pawl transmission path side of the connection between the pawl lifter and the first pawl.

Preferably the release mechanism is connected to an outside door handle.

This form of the invention will now be described, by way of example only, with reference to the accompanying drawings and drawing sheets 18/37 to 37/37 in which:-

Figure 1 is a view of a latch arrangement according to this form of the present invention in an unlocked latched first condition.

Figure 2 is a view of figure 1 part way through a first actuation of the release mechanism.

Figure 3 is a view of figure 1 having completed the first actuation.

Figure 4 is a view of the latch of figure 1 with the release mechanism having been released and with the latch in a latched second condition.

Figure 5 is a view of the latch of figure 1 shown in a released position, having been mechanically released,

Figure 6 is a view of figure 1 shown in a released position having been released by a power actuator,

Figure 7 is a view of figure 1 shown in a locked condition,

Figure 8 is a view of figure 1 shown in an unlatched condition with the release handle in a rest position.

Figure 9 is a view of various components of figure 1 shown in isolation for clarity.

Figure 10 is a view of the claw of figure 1 shown in isolation.

Figure 11 is a view of a further embodiment of the present invention.

Figures 1A to 7A are views corresponding to figures 1 to 7 respectively, of a further embodiment of a latch arrangement according to the present invention.

Figure 12 is a view of the embodiment of figure 1A shown in a locked condition with the outside handle pulled, and

Figure 13 is a close up view of part of figure 1A.

Figures 1 to 5 show sequentially the sequence of events required to manually release the latch, in the event of failure of the power unlatching actuator. With reference to figures 1 to 5 there is shown a latch arrangement 10 including a latch 12 and a release mechanism 14. The latch 12 includes a pivotally mounted latch bolt in the form of claw 16. Claw 16 can move between its closed position as shown in figure 1, whereupon it retains a striker 18, and an open position as shown in figures 5, 6 and 8, wherein the striker 18 is released, thus allowing opening of the door.

The claw can also be retained in a "first safety" position (not shown) whereupon the associated door cannot be opened, but nevertheless is not fully shut.

The latch further includes a first pawl 20 pivotally mounted to a chassis 13 (shown schematically) of the latch at pivot B. Pawl 20 includes a pawl abutment 22 for engagement with claw abutment 24 or claw first safety abutment 26. The claw includes a claw release abutment 27 against the end 27A of which the pawl abutment 22 rests when the claw is in the open position (figures 5, 6 and 8). It should be noted that claw release abutment 27 is positioned at a radius R1 which is greater than radius R2 of the claw abutment 24 and first safety abutment 26. Thus, with the latch in a closed or first safety position, claw abutment 22 sits at radius R2 relative to axis A, which is closer to axis A than when the pawl abutment 22 is resting on claw release abutment 27 when the latch is in the open position. Pawl 20 is generally planar and sits below pawl lifter 28 when viewing figure 1. Pawl lifter is also generally planar. Pawl lifter 28 is also pivotally mounted at pivot B.

Pawl lifter 28 includes first ratchet tooth 32 and second ratchet tooth 34. Pawl lifter 28 also includes abutment 36.

Second pawl 38 is pivotally mounted at pivot C to the chassis of the latch.

Second pawl can be engaged with end 36A of abutment 36 as shown in figures 3 and 4 and can be disengaged from end 36A as shown in figures 1, 2 and 5, as will be further described below.

Outside release lever 40 is connected to an outside release handle (not shown) at end 42. Outside release lever 40 is pivotally attached to the chassis 13 of the latch at pivot D. Outside release lever 40 includes a projection 44.

Pivotally mounted at pivot E (situated between pivot D and end 42) is ratchet lever 46. Ratchet lever 46 includes ratchet abutment 48, remote from pivot E.

Situated between ratchet abutment 48 and pivot E is a first link pivot F which pivotally connects link 50 with ratchet lever 46. The end of link 50 remote from first link pivot F is pivotally mounted, at second link pivot G, to end 52A of lock link 52.

Lock link 52 is pivotally mounted at pivot H to the chassis of the latch. End 52B of lock link 52 includes a lock abutment 54. Between pivot H and end 52A, lock link 52 further includes a return abutment 56.

Lock toggle 58 is pivotally mounted at pivot J to the chassis of the latch and includes toggle abutment 60. Lock toggle 58 forms the toggle part of an actuator 58A according to the present invention, only shown in figure 7 for clarity. Actuator 58A further includes electro magnetic coil assembly 58B, core 58C and frame 58D, one end of which is connected to coil 58C. Operation of the actuator 58A to move the toggle 58 between the position shown in figure 7 and the position shown in for example figure 1 is substantially as hereinbefore described with reference to the previously mentioned actuators.

Lock link 52, outside release lever 40, pawl lifter 28 and first pawl 20 are all biased in an anti-clockwise direction by appropriate bias means, such as springs (not shown). Claw 16 and second pawl 38 are both biased in a clockwise direction by appropriate bias means, such as springs (not shown). The movement of link 50 and ratchet lever 46 is controlled by the combination of the lock link 52, outside release lever 40 and pawl lifter 28, and hence link 50 and ratchet lever 46 are not required to be biased either clockwise or anti-clockwise. Lock toggle 58 can be moved between positions shown in figures 1 and 7 by an actuator (not shown).

An actuator 64 (shown schematically on figure 6 only) is connected to the first pawl and can be actuated to rotate the first pawl in a clockwise direction so as to release the latch.

Note that in further embodiments, the actuator 64 could be connected to the pawl lifter 28 (as shown in dashed line in figure 6) in order to rotate the pawl lifter, and hence the pawl in a clockwise direction to release the latch.

In the event of failure of the actuator 64, operation of the latch arrangement is as follows.

Consideration of figure 1 shows the latch in a latched condition wherein pawl abutment 22 engages claw abutment 24 retaining the claw in its closed position.

A comparison of figures 1 and 7 shows that all components are in an identical position other than toggle lock 58. As shown in figure 1 toggle lock 58 has been pivoted anticlockwise such that lock abutment 54 does not align with toggle abutment 60, and as shown in figure 7 lock toggle 58 has been pivoted clockwise such that lock abutment 54 is aligned with toggle abutment 60. Figure 7 shows the latch arrangement in a locked condition and figure 1 shows the latch arrangement in an unlocked condition. However, it should be noted that, as shown in figure 1, the lock link 52 is nevertheless in a lockable position, since toggle lock 58 can be pivoted clockwise. This can be contrasted with the position of lock link 52 as shown in figure 2 and 3 wherein it is not in a lockable position since lock toggle 58 cannot be pivoted clockwise.

It should also be noted that projection 44 of outside release lever 40 is in engagement with return abutment 56 of lock link 52. This engagement causes lock link 52 to be positioned as shown in figure 1, i.e. clockwise when compared with the position of lock link 52 as shown in figure 2.

In figure 2, the outside release lever 40 has been pivoted clockwise about pivot D through angle K. This has also moved projection 44 clockwise about pivot D in the general direction of arrow X. This in turn has allowed lock link 52 to pivot anticlockwise, moving link 50 generally to the right when viewing figure 2.

This in turn has caused ratchet lever 46 to pivot clockwise about pivot E such that ratchet abutment 48 is substantially engaged behind first ratchet 32. It should be pointed out that, at this stage, pawl lifter 28 and first pawl 20 remain in the same position in figure 2 when compared with figure 1.

Figure 3 shows the outside release lever 40 having been moved to its fully actuated position. It can be seen that lock link 52 remains in the same position when comparing figures 2 and 3. However, ratchet lever 46 has been moved generally upwards and the

engagement between ratchet abutment 48 and first ratchet tooth 32 has caused the pawl lifter 28 to pivot clockwise when compared with figure 2. This clockwise rotation of pawl lifter 28 has allowed abutment 38A of second pawl 38 to slide past edge 36B of abutment 36 and engage end 36A of abutment 36, thus preventing pawl lifter 28 from rotating anti-clockwise about pivot B.

Furthermore, pawl lifter abutment 62 has approached arm 20A of pawl 20 but as shown in figure 3 not yet moved arm 20A. As it can be seen that the pawl lifter is moveable relative to the first pawl by virtue of lost motion connection between pawl lifter and the first pawl. In a further embodiment this lost motion connection can be in the form of a projection on one of the pawl lifter and first pawl engaging in a slot in the other of the pawl lifter and the first pawl.

It can be seen that this first actuation of the outside release lever has moved components 40, 52, 50, 46, 28 and 38. However, as shown in figure 3, the latch, i.e. claw 16 and first pawl 20, remain unmoved, and in the same position as shown in figure 1 and 2.

Figure 4 shows the outside release lever having been released and returned to the position as shown in figure 1. This in turn, has also moved components 52, 50 and 46 to the position shown in figure 1. However, pawl lifter 28 remains in the position as shown in figure 3 by virtue of second pawl 38. In particular it should be noted that as shown in figure 4, second ratchet tooth 34 is now presented in substantially the same position as first ratchet tooth 32 as shown in figure 1.

Thus, a subsequent actuation of the outside release lever 40 causes ratchet abutment 48 to engage behind second ratchet tooth 34 and further rotate the pawl lifter 28 to the position as shown in figure 5. However, in this case pawl lifter abutment 62 causes arm 20A to rotate clockwise about pivot B thus releasing pawl abutment 22 from claw abutment 24 and allowing the claw 16 to rotate clockwise to its open position.

It should be noted from figure 5 that the second pawl 38 has been disengaged from pawl lifter abutment 36 of the pawl lifter. This is due to an abutment (not shown) on the 1st pawl being moved (as the 1st pawl rotates) in to engagement with the second pawl and hence rotating the second pawl anticlockwise against the 2nd pawl bias spring.

Thus, upon release of the outside release lever 40, the pawl lifter abutment 36, can bypass end 38A of second pawl 38 so as to achieve the position shown in figure 8.

With the actuator 64 operating correctly, operation of the latch arrangement is as follows.

The latch starts from the position as shown in figure 1.

An initial operation of the outside door handle manually moves the latch components to the position as shown in figure 2. At this stage a sensing device, such as a switch, is triggered, which instructs the actuator to rotate the first pawl in a clockwise direction. However, the power actuator does not act instantaneously, and takes a finite amount of time rotate the first pawl. Thus, the continued lifting of the outside door handle might typically position the latch components somewhere between the position as shown in figures 2 and 3 prior to the latch being power unlatched. Under these circumstances clearly no subsequent manual operation of the outside door handle is required and the latch might typically move from the position shown in figure 3 to the position shown in figure 6. Release of the outside door handle will then move the latch components to the position shown in figure 8.

Operation of the latch arrangement when in the locked position shown in figure 7 is as follows.

As mentioned above the toggle lock 58 has been rotated clockwise such that lock abutment 54 engages with toggle abutment 60. This prevents lock link 52 rotating anticlockwise and hence second link pivot G remains fixed relative to the chassis. Thus, first link pivot F is constrained to move about an arc centred at second link pivot G. Thus, when the outside release lever 40 is actuated the ratchet abutment 48 moves substantially upwardly when viewing figure 7 and bypasses the first ratchet tooth 32, without engaging it. Hence, the actuation of the outside release lever does not move the pawl lifter, and the latch remains latched.

It should be noted that, in a further embodiment, the actuator 64 need not be present. Thus, the latch can only be opened manually and two actuations of the outside door handle will be required to open the latch.

Advantageously, this arrangement has safety benefits in the event of a side impact on the vehicle. Thus, whilst a side impact on the vehicle door may well deform the door such that the latch components move from the position shown in figure 1 through the position shown in figure 2 to the position shown in figure 3, under such circumstances the door does not open. This can be contrasted with known door latches wherein a single pull of the outside door handle opens the door and such known latches therefore run the risk that a single side

impact to the door will also move the latch components to their unlatched position and hence allow the door to open.

With reference to figure 11 there is shown a further latch arrangement 110, similar to the latch arrangement 10, with components that fulfil substantially the same function labelled 100 greater. Figure 11 shows the latch 110 in a latched condition, similar to the condition of latch 10 shown in figure 1. In this case, the only difference between latch arrangement 110 and latch arrangement 10 is that latch arrangement 110 does not include a lock toggle 58. Thus, latch arrangement 110 can be power unlatched or manually unlatched (when its power actuator fails) in a similar manner to latch 10. However, latch 110 cannot be locked.

It should be noted that latch arrangement 110 is in an unlocked latched first condition as shown in figure 11 by virtue of the fact that this latch cannot be locked.

In a further embodiment the actuator associated with latch arrangement 110 can be deleted to provide a non power operable latch arrangement which cannot be locked.

In a further embodiment of a non lockable latch, the lock link 152 and the link 150 of latch 110 can be deleted and replaced by a bias means, such as a spring, which lightly biases the ratchet lever 46 in a clockwise direction so as to ensure engagement of ratchet abutment 148 with appropriate ratchet teeth 132 and 134.

It should also be noted that in this embodiment the ratchet teeth and ratchet abutment are in substantially permanent operable engagement and hence the latch cannot be locked by virtue of disengagement of the ratchet teeth and ratchet abutment (though in yet further embodiments, the latch could alternatively be locked by virtue of a block mechanism or a free wheel type mechanism positioned somewhere in the transmission path between the outside door handle and the first pawl.

With reference to figures 1A to 7A there is shown a further embodiment of a latch arrangement 210 wherein features which perform substantially the same function as in latch arrangement 10 have been labelled 200 greater. Only the toggle 258 of the actuator according to the present invention has been shown for clarity. Note also that pivots 2E, 2D and 2H as shown in figure 2A are the functional equivalents of pivots E, D and H of latch arrangement 10.

Consideration of figure 13 shows that lock link 252 is pivotally mounted at pivot 2H which is coincident with pivot 2D about which outside release lever 240 pivots. Furthermore, a

pin 267 on ratchet lever 246 projects between a slot formed by guides 268 of lock link 252. This pin and slot arrangement replaces link 50 of latch arrangement 10.